PROGRESS REPORT

State: New Hampshire **Grant:** F-61-R

Title: NEW HAMPSHIRE'S MARINE FISHERIES INVESTIGATIONS

Project I: ANADROMOUS FISH INVESTIGATIONS

Job 2: River Herring Restoration and Evaluation

Objective: To restore river herring (*Alosa pseudoharengus* and *Alosa aestivalis*) to their former abundance and distribution in the coastal areas of New Hampshire to the extent possible, and monitor the adult spawning populations.

Period Covered: January 1, 2002 - December 31, 2002

Abstract:

Seven department fish ladders on six coastal rivers were operated during the spring of 2002 to facilitate the passage of river herring and other anadromous fish over dams. Estimated numbers of river herring monitored in 2002 were higher in the Cocheco, Lamprey, and Winnicut rivers and lower in the Exeter, Oyster, and Taylor rivers compared to 2001. The recent modifications to the Winnicut River fishway, have lead to the highest return to date in 2002.

Alewives made up 100% of the returns in the Lamprey River and dominated returns in the Cocheco and Exeter rivers. This shows a return from the 2001 blueback-dominated run to the historical alewife-dominated runs of the Exeter River. River herring returns in the Oyster and Taylor rivers were exclusively blueback herring in 2002.

Age analysis of scale samples indicated age IV and V individuals made up large proportions of spawning river herring to all rivers except the Lamprey and Taylor rivers, where the age V and VI fish were greatest. Age VI individuals made up 30% and 53% of the ageing samples in the Lamprey and Taylor Rivers respectively, but less than 20% in all other rivers. The percentages of age III individuals declined this year in all rivers with previous age structure data from 2001. Due to low returns and complexities in capturing river herring at the Taylor and Exeter rivers fishway, a limited number of biological samples were collected in 2002.

In a concerted effort between New Hampshire Fish and Game and the U.S.

PROGRESS REPORT

State: **New Hampshire** **Grant: F-61-R**

Grant Title: **NEW HAMPSHIRE'S MARINE FISHERIES INVESTIGATIONS**

Project 1: **ANADROMOUS FISH INVESTIGATIONS**

Job 7: **Coastal Netter's Program**

Job Objective: To collect catch and effort information from coastal harvesting targeting and catching recreationally important marine species.

Job Duration: January 1, 2002 - December 31, 2002

Abstract:

Individuals who obtain a Harvest Permit to take marine species in coastal waters are required to complete and submit mandatory logbooks on a monthly basis. The reporting compliance rate for this program in 2002 was 97% with four individuals, out of 132 permittees, not reporting.

The total annual harvest from New Hampshire coastal and estuarine waters reported by permittees was 147,571 lbs. of marine species. This exceeds 2000's total of 35,255 lbs. and is lower than 2001's, which was 195,662. Due to stricter regulations in the Exclusive Economic Zone (EEZ), a directed gill net fishery for dogfish occurred in state waters and was responsible for the large increase in reported harvest by permit holders in 2001 and 2002. Dogfish represented the majority of the harvested marine species followed by river herring, surf clams, Atlantic herring and Atlantic mackerel among other species. No rainbow smelt were harvested in 2002 due to poor ice conditions.

Eight different types of gear were used to harvest various species from New Hampshire waters in 2002. Gill nets were used to harvest the widest variety of species and were responsible for 100% of the harvest for seven different species. The most diverse methods were used to harvest river herring. Wire baskets and cast nets harvested the majority of river herring but dip nets and gill nets were also used. Minnow traps were used to harvest 100% of the killifish as well as a small percentage of American eels. Eel pots however, accounted for 82% of the American eels harvested.

A clam dredge was used to take surf clams for recreational fisheries bait needs.

Introduction:

In New Hampshire, persons harvesting American eels and horseshoe crabs by any method or marine species by seine, net, weir, pot, or trap from coastal and estuarine waters are required to obtain a Harvest Permit from the New Hampshire Fish and Game Department. The permittees are required to complete monthly logbooks on their effort and harvest. Collection of this information fills a gap in the fishery dependent data collection program. The vast majority of these harvesters either harvest exclusively in state waters or retain the marine species they catch for personal use (food, bait, etc.). Thus, the information is not captured by the National Marine Fisheries Service's (NMFS) commercial weigh-out program. Due to certain gear restrictions (i.e. no mobile gear in state waters), few traditional commercial finfish operations in New Hampshire obtain this permit. In fact, the vast majority of people obtaining the permit are recreational anglers seeking bait for various recreational fisheries such as striped bass and bluefish.

Many of the fish targeted and retained by these harvesters, such as river herring and American eels are forage for important recreational finfish species. Rainbow smelt, an important recreational species as well as an important forage fish, are also targeted by coastal harvesters.

The information from the mandatory logbooks from coastal harvesters provides annual harvest and effort information useful for improving the quality of stock assessments and for fishery management.

Procedures:

Mandatory logbooks are required to be submitted on a monthly basis for those months an individual held a permit to harvest marine species within coastal or estuarine waters of New Hampshire. The required elements to report in the logbook include date fished, species harvested, quantity of species retained, area fished, type of gear, effort (in hours), size of gear, number of gear used, and quantity of by-catch by species. The reports are required to be submitted by the tenth day of the following month for those months the individual is permitted to harvest, whether effort occurred or not. Reporting is mandatory. Permits for subsequent years are not

issued to an individual until the previous years reporting requirements have been met.

The reported data are requested in either weight or quantity. All quantitative data are converted to weight using the following conversions.

Species	Conversion
American Eel	4 eels = 1 lb.
River Herring	1 fish = .5 lbs.
Killifish	1 lq. quart = 1.125 lbs. 275 fish = 1 lq. quart
Horseshoe Crab	1 male = 0.28 lbs 1 female = 0.73 lbs
Atlantic Mackerel	1 fish = 1.125 lbs
Surf Clams	45 lbs. = 1 Bushel

The data are compiled by species harvested (lbs.), effort and catch per unit effort (CPUE). Effort measurements for each gear are presented in the table below.

Gear	Effort
Cast Net	Hours Fished
Clam Dredge	Hours Fished
Dip Net	Hours Fished
Eel Pot	Trap Haul Set Over Days (THSOD)
Gill Net	(Net Area/100)*Hours Fished
Minnow Trap	Trap Haul Set Over Days (THSOD)
Wire Basket	Hours Fished

If the number of reporting harvesters for a single species is below 3, effort and location data are not published in order to protect the confidentiality of the reported data.

Results:

Of the 132 coastal harvest permittees in 2002, the reporting compliance rate was 97 percent with four non-reporters. The total reported weight of all species harvested in 2002 was 147,571 pounds (Table 7-1). Seven different types of gear plus collection by hand were used to harvest various species from New Hampshire waters in 2002. Gill nets were used to harvest the widest variety of species and were responsible for 100% of the harvest for seven different species. The most diverse methods were used to harvest river herring.

Dogfish (Squalidae and Triakidae) represented the highest percentage of the harvest (87.4%) in 2002 with a total weight of 129,000 pounds; this is a decrease from 2001's 153,400 pounds (Table 7-2). The dogfish were targeted by a gill net fishery in the month of November (Table 7—3) near the Isles of Shoals (Table 7-4). In comparison to other species harvested by the gill net, the dogfish gill net CPUE was the lowest at 0.02 (Table 7-5).

A small gill net fishery for groundfish occurred in January, February, October and November in state waters. There are three species listed in Table 7-1 from this fishery, Atlantic cod (*Gadus morhua*), Atlantic wolfish (*Anarchichas lupus*), and pollock (*Pollachius virens*). Total harvest by this fishery was 92 pounds representing <0.1% of the total reported harvest by permit holders. Atlantic cod represented the largest harvested groundfish species (40 pounds) from this gill net fishery. Due to the low number of participants in this fishery, specific area and effort data are not shown in order to protect confidentiality of the data.

Seven species harvested in 2002 were used as bait fish. These species include Atlantic herring (*Clupea harengus*), Atlantic mackerel (*Scomber scombrus*), killifish (Cyprinodontidae) American eels (*Anguilla rostrata*) surf clams (*Spisula solidissima*), horseshoe crabs (*Limulus polyphemus*) and river herring (*Alosa pseudoharengus and Alosa aestivalis*). A complete summary of effort and CPUE by species, gear, and area per month is presented in Table 7-6.

The majority of the river herring were harvested from the Squamscott River using a wire basket during May (Tables 7-4), with a CPUE of over 160 fish/hour (Table 7-5). The eighty-one pounds of white perch (*Morone americana*) reported (Table 7-1) were a bycatch of the river herring fishery.

There was no harvest of rainbow smelt (*Osmerus mordax*) in 2002 although there was a small amount of effort in January by dip nets when ice existed briefly during the mild winter (Table 7-5).

Surf clams and horseshoe crabs were the only species of marine invertebrates harvested in state waters during 2002 by Harvest Permittees. Due to the low number of participants in these fisheries, specific area and effort data are not shown in order to protect confidentiality of the data.

Discussion:

Mandatory reporting of various netting activities in New Hampshire coastal and estuarine waters closes a reporting gap between commercial harvesting in federal waters that is reported to NMFS, and those harvesting in state waters. Some of the harvested finfish species are not only an important forage base for recreationally important fish (e.g. striped bass) but are also used widely for bait in recreational and commercial fisheries for such species as striped bass, bluefish and lobsters.

The anadromous river herring is a prime example of this. They are an important forge fish in both freshwater as young-of-the-year and the marine environment as juveniles and adults. River herring are also a highly sought after bait for both recreational anglers and the lobster fishery as indicated by their harvest over the last five years (Table 7-2). The largest harvest and effort comes during the spawning runs up coastal rivers in May and June (Table 7-1 and 7-4). The method of capture varied in 2002 with wire baskets and cast nets catching the majority of the harvest (Table 7-3). While there was an overall increase in the river herring spawning returns to New Hampshire in 2002 (see Project I Job 2) there was a decline of river herring harvested compared to the last two years (Table 7-2). This may be a result of a decline in river herring spawning returns to the Squamscott River, which is a primary location for the harvest of this species. In addition, the remaining weir fisherman in New Hampshire did not fish in 2002. An incidental catch of white perch (81 pounds) was harvested by the river herring gill net fishery in May.

While diverse gear types were used to harvest river herring, other species seem to be targeted by a single gear type (Table 7-3). Surf clams were captured for bait using a clam dredge, horseshoe crabs were harvested solely by hand, minnow traps harvested killifish and gill nets were used in

the groundfish, dogfish, herring and mackerel fisheries. Gill nets were responsible for the harvest of the widest variety of species in 2002.

As stricter federal regulations on groundfish and dogfish are enacted in the EEZ, netters seek alternative species or areas to fish as seen with the reported dogfish and small groundfish harvest in 2002. Dogfish harvest had not previously been reported through this program prior to 2001 but accounted for the largest portion of the reported catch by permit holders in the past two years (Table 7-2). In addition, groundfish species had previously not been reported prior to 2001. Compared to 2001 when nearly 4% of the reported harvest consisted of groundfish, 2002's reported groundfish harvest declined to less than 0.1% of the total. This is most likely due to the lower number of state permitted groundfish fishermen.

The majority of killifish and American eels were caught by gear distinctive to their fisheries. Eel pots harvested 82% of the American eel reported catch while minnow traps caught 100% of the killifish.

American eels have become an important bait fish for striped bass and therefore are sought more from late spring through early fall when striped bass are in New Hampshire waters. Killifish are used primarily for bait during both winter freshwater ice fisheries and summer freshwater fishing seasons. This is reflected in the seasonal variability of the effort directed at this species (Table 7-5). Catching killifish was easier during the summer months than during the winter months as indicated by higher CPUE from May through October. This could be due to the ease in accessing the shoreline to set and tend traps or pots during the summer months as opposed to the winter months when ice limits the available area for setting traps. Also, harvest rates may be slower during winter months when colder water temperatures result in fish being less active.

During 2002, Atlantic mackerel harvesters used gill nets as the principal harvest gear. Another popular method for harvesting mackerel bait is by hook and line. Those using this gear are not required to report under the Harvest Permit, but would be accounted for under the Marine Recreational Fishing Statistical Survey (MRFSS).

Only three species have been consistently harvested from New Hampshire coastal waters since 2000 (Table 7-2). The need for bait for recreational and lobster fisheries has maintained the American eel, killifish, and river herring fisheries.

Species of fish harvested in past years that were not reported in 2002 were rainbow smelt, northern shrimp and certain groundfish (Table 7-2). The opportunity to fish bow nets and dip nets for smelt was extremely limited in 2002 due to the limited presence of ice to fish from (see Project 1, Job 3). The only effort reported was in January by dip netters. There was no reported effort directed at northern shrimp in state waters as fishermen who formally targeted shrimp in state waters were known to be actively fishing in federal waters. The relatively low effort directed at groundfish in state waters most likely resulted in the reduced variety of groundfish reported in these logbooks.

Since the reporting is not verified, some of the species of finfish may be misidentified. Clupeids including river herring, menhaden and sea herring, have similar morphological characteristics. Since schools of these species migrate along the coast at various times of the year, the layman may not be able to distinguish between these similar looking fish and may misreport what species have been harvested. Attempts should be made to assist harvesters in the identification of certain species to reduce the chance of misreporting.

In summary, due to stricter federal regulations, displaced netters who normally fish in the EEZ harvested 129,000 pounds of dogfish, representing the largest single species harvest in 2002. The groundfish gill net fishery harvested the most diverse species in state waters. The reported river herring harvest declined from the last two years despite an overall increase in the total river herring spawning returns to New Hampshire in 2002. Species harvested for use as bait in New Hampshire’s recreational fisheries and lobster fisheries continue to be an important commodity in state waters. American eels, killifish, Atlantic herring, Atlantic mackerel, river herring and surf clams are some of the species that are reported harvested by Harvest Permittees.

Table 7-1. Total weight (lbs.) of harvested marine species and percentage of annual harvest, by species and month, from coastal harvesting in NH coastal and estuarine waters in 2002.

Species	Weight of Harvest (lbs.)												% of Annual Harvest	Annual Harvest 2002
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
American Eels	-	-	-	-	3	14	1	42	-	-	-	-	<0.1%	60
Atlantic Cod*	-	20	-	-	-	-	-	-	-	-	20	-	<0.1%	40
Atlantic Herring	-	-	-	-	-	75	-	275	1050	125	-	-	1.0%	1,525
Atlantic Mackerel	-	-	-	-	-	202	534	-	-	-	-	-	0.5%	736
Atlantic Wolffish*	10	-	-	-	-	-	-	-	-	-	15	-	<0.1%	25
Dogfish	-	-	-	-	-	-	-	-	-	-	129,000	-	87.4%	129,000
Horseshoe Crab	-	-	-	-	-	88	-	-	-	-	-	-	<0.1%	88
Killifish	-	-	5	4	7	5	20	19	9	3	-	5	<0.1%	77
Pollock*	-	-	-	-	-	-	-	-	-	27	-	-	<0.1%	27
River Herring	-	-	-	-	11,532	2,085	-	-	-	-	-	-	9.2%	13,617
Surf Clams	-	-	-	-	-	2,003	292	-	-	-	-	-	1.5%	2,295
White Perch	-	-	-	-	81	-	-	-	-	-	-	-	<0.1%	81
Monthly Total	10	20	5	4	11,623	4,472	847	336	1059	155	129,035	5		147,571
Monthly Percentage	<0.1%	<0.1%	<0.1%	<0.1%	8.0%	1.7%	0.4%	0.2%	0.7%	<0.1%	88.8%	<0.1%		

* - Groundfish Fishery

Table 7-2. Total weight (lbs.) of harvested marine species, by species and year, from coastal harvesting in NH coastal and estuarine waters

Species	Weight of Harvest (lbs.)				
	2002	2001	2000	1999	1998
American Eels	61	185	310	246	422
American Shad*	-	132	-	-	-
Atlantic Cod*	40	5,687	-	-	-
Atlantic Herring	1,525	242	-	-	-
Atlantic Mackerel	736	40	-	90	1,220
Atlantic Wolffish*	25	-	-	-	-
Cusk*	-	16	-	-	-
Dogfish	129,000	153,400	-	-	-
Flounder, Winter*	-	20	-	-	-
Flounder, Yellowtail*	-	2	-	-	-
Haddock*	-	9	-	-	-
Hake, Silver*	-	394	-	-	-
Hake, White*	-	45	-	-	-
Horseshoe Crab	88	-	288	-	-
Monkfish*	-	356	-	-	-
Killifish	77	52	317	447	560
Northern Shrimp	-	18,180	12,150	6,577	-
Pollock*	27	983	-	-	-
Rainbow Smelt	-	113	27	37	-
Redfish*	-	26	-	-	-
River Herring	13,617	14,129	22,141	19,049	25,993
Sand Shrimp	-	-	2	-	-
Sea Scallops	-	-	-	1,117	-
Silversides	-	-	20	2	9
Skates*	-	9	-	-	-
Surf Clams	2,296	1,640	-	-	-
White Perch	81	-	-	-	-
Windowpane*	-	2	-	-	-
Yearly Total	147,573	195,662	35,255	27,565	28,204

* - Groundfish Fishery

Table 7-3. Percent weight composition, by gear type, for harvested marine species by coastal netting in NH coastal and estuarine waters in 2002.

Species	Percent Weight Composition by Gear							
	Gill Net	Dip Net	Hand	Wire Basket	Cast Net	Minnow Trap	Eel Pot	Clam Dredge
American Eel						17.9%	82.1%	
Atlantic Cod	100%							
Atlantic Herring	100%							
Atlantic Mackerel	100%							
Atlantic Wolffish	100%							
Dogfish	100%							
Horseshoe Crabs			100%					
Killifish						100%		
Pollock	100%							
River Herring	2.2%	16.9%		46.1%	34.8%			
Surf Clams								100%
White Perch	100%							

Table 7-4. Reported harvested weight (lbs.) of marine species from coastal netting activity in NH coastal and estuarine waters, by month and area, in 2002.

Month/ Area	American Eels	Atlantic Herring	Atlantic Mackerel	Dogfish	Killifish	River Herring
January						
Isles of Shoals	-	-	-	-	-	-
February						
Isles of Shoals	-	-	-	-	-	-
March						
Grt Bay-Bay Rd-Marsh	-	-	-	-	4.5	-
April						
Bellamy R.	-	-	-	-	2.25	-
Oyster R.	-	-	-	-	1.69	-
May						
Bellamy R.	-	-	-	-	2.81	346.5
Little Bay	2.5	-	-	-	-	-
Oyster R.	-	-	-	-	3.94	133.5
Salmon Falls R.	-	-	-	-	-	28
Squamscott R.	-	-	-	-	-	11,024.2
June						
Bellamy R.	-	-	-	-	3.66	143.5
Hampton-Coastal	-	-	27	-	-	-
Lamprey R.	-	-	-	-	-	21
Little Bay	3.25	-	-	-	-	-
Oyster R.	-	-	-	-	1.13	103
Salmon Falls R.	-	-	-	-	-	99.5
Cocheco R.	-	-	-	-	-	20
Great Bay	7	-	-	-	-	-
Seabrook-Coastal	-	75	175	-	-	-
Squamscott R.	4.5	-	-	-	-	1,697.5
July						
Bellamy R.	-	-	-	-	16.31	-
Hampton-Coastal	-	-	89.4	-	-	-
Great Bay	0.75	-	-	-	-	-
Oyster R.	-	-	-	-	3.38	-
Seabrook-Coastal	-	-	445	-	-	-
August						
Bellamy R.	-	-	-	-	19.49	-
Seabrook-Coastal	-	275	-	-	-	-
Squamscott R.	42	-	-	-	-	-
September						
Bellamy R.	-	-	-	-	9.23	-
Seabrook-Coastal	-	1,050	-	-	-	-
October						
Bellamy R.	-	-	-	-	3.38	-
Hampton-Coastal	-	-	-	-	-	-
Seabrook-Coastal	-	125	-	-	-	-
November						
Isles of Shoals	-	-	-	129,000	-	-
December						
Grt Bay-Bay Rd.-Marsh	-	-	-	-	5	-

Table 7-5. Effort and catch per unit effort (CPUE) of coastal netters in NH coastal and estuarine waters, by species and gear type, for each month in 2002.

Species	Effort and CPUE											
	Jan		Feb		Mar		Apr		May		June	
	Effort	CPUE	Effort	CPUE	Effort	CPUE	Effort	CPUE	Effort	CPUE	Effort	CPUE
American Eel												
Eel Pot	-	-	-	-	-	-	-	-	-	-	51	0.12
Minnow Trap	-	-	-	-	-	-	-	-	7	0.35	48.25	0.17
Atlantic Herring												
Gill Net	-	-	-	-	-	-	-	-	-	-	288	0.26
Atlantic Mackerel												
Gill Net	-	-	-	-	-	-	-	-	-	-	297	0.68
Dogfish												
Gill Net	-	-	-	-	-	-	-	-	-	-	-	-
Killifish												
Minnow Trap	0.29	0	-	-	15	0.3	2.75	1.43	1.58	4.26	2.74	1.73
Rainbow Smelt												
Dip Net	0.5	0	-	-	-	-	-	-	-	-	-	-
River Herring												
Cast Net	-	-	-	-	-	-	-	-	81.31	54.65	15.32	19.21
Dip Net	-	-	-	-	-	-	-	-	15.6	104.85	30.57	21.94
Gill Net	-	-	-	-	-	-	-	-	65.55	2.12	63.97	2.43
Wire Basket	-	-	-	-	-	-	-	-	32.23	164.79	12	80.25

Table 7-5. (cont.)

Species	Effort and CPUE												Total by Species & Gear	
	July		Aug		Sept		Oct		Nov		Dec			
	Effort	CPUE	Effort	CPUE	Effort	CPUE	Effort	CPUE	Effort	CPUE	Effort	CPUE	Effort	CPUE
American Eel														
Eel Pot	56	0.01	119	0.35	-	-	-	-	-	-	-	-	226	0.21
Minnow Trap	-	-	-	-	-	-	-	-	-	-	-	-	55.25	0.19
Atlantic Herring														
Gill Net	-	-	280	0.98	216	4.86	350	0.35	-	-	-	-	1,134	1.34
Atlantic Mackerel														
Gill Net	7,234.5	0.07	-	-	-	-	-	-	-	-	-	-	7,531.5	0.09
Dogfish														
Gill Net	-	-	-	-	-	-	-	-	4,491,144	0.02	-	-	4,491,144	0.02
Killifish														
Minnow Trap	2.91	6.75	6.25	3.11	3.5	2.63	0.5	6.76	-	-	22	0.22	57.54	1.33
Rainbow Smelt														
Dip Net	-	-	-	-	-	-	-	-	-	-	-	-	0.5	0
River Herring														
Cast Net	-	-	-	-	-	-	-	-	-	-	-	-	96.64	49.03
Dip Net	-	-	-	-	-	-	-	-	-	-	-	-	46.18	49.95
Gill Net	-	-	-	-	-	-	-	-	-	-	-	-	129.52	2.28
Wire Basket	-	-	-	-	-	-	-	-	-	-	-	-	44.23	141.86

Table 7-6. Reported effort and catch per unit effort (CPUE) of marine species from coastal netting activity in NH coastal and estuarine waters by month, area, and gear type in 2002.

Month/Area/Gear	American Eels		River Herring		Atlantic Herring		Killifish		Rainbow Smelt		Dogfish		Atlantic Mackerel	
	Effort	CPUE	Effort	CPUE	Effort	CPUE	Effort	CPUE	Effort	CPUE	Effort	CPUE	Effort	CPUE
January														
North Mill Pond														
Minnow Trap	-	-	-	-	-	-	0.12	0	-	-	-	-	-	-
South Mill Pond														
Minnow Trap	-	-	-	-	-	-	0.16	0	-	-	-	-	-	-
Squamscott R.														
Dip Net	-	-	-	-	-	-	-	-	0.5	0	-	-	-	-
March														
Grt Bay-Bay Rd-Mrsh														
Minnow Trap	-	-	-	-	-	-	15	0.3	-	-	-	-	-	-
April														
Bellamy R.														
Minnow Trap	-	-	-	-	-	-	1.66	1.35	-	-	-	-	-	-
Oyster R.														
Minnow Trap	-	-	-	-	-	-	1.08	1.55	-	-	-	-	-	-
May														
Bellamy R.														
Minnow Trap	-	-	-	-	-	-	0.66	4.21	-	-	-	-	-	-
Dip Net	-	-	2	52.5	-	-	-	-	-	-	-	-	-	-
Cast Net	-	-	3	80.5	-	-	-	-	-	-	-	-	-	-
Little Bay														
Minnow Trap	7	0.35	-	-	-	-	-	-	-	-	-	-	-	-
Oyster R.														
Minnow Trap	-	-	-	-	-	-	0.91	4.29	-	-	-	-	-	-
Gill Net	-	-	9.55	9.37	-	-	-	-	-	-	-	-	-	-
Cast Net	-	-	1.5	29.33	-	-	-	-	-	-	-	-	-	-
Salmon Falls R.														
Dip Net	-	-	1	28	-	-	-	-	-	-	-	-	-	-
Squamscott R.														
Gill Net	-	-	56	0.89	-	-	-	-	-	-	-	-	-	-
Dip Net	-	-	12.6	119.26	-	-	-	-	-	-	-	-	-	-
Wire Basket	-	-	32.23	164.79	-	-	-	-	-	-	-	-	-	-
Cast Net	-	-	76.81	54.14	-	-	-	-	-	-	-	-	-	-
June														
Bellamy R.														
Minnow Trap	-	-	-	-	-	-	2.41	1.51	-	-	-	-	-	-
Gill Net	-	-	7.87	10.15	-	-	-	-	-	-	-	-	-	-
Cast Net	-	-	2.5	25.4	-	-	-	-	-	-	-	-	-	-

Hampton-Coastal														
Gill Net	-	-	-	-	-	-	-	-	-	-	-	-	9	3
Johnson Creek														
Eel Pot	7	0	-	-	-	-	-	-	-	-	-	-	-	-
Lamprey R.														
Gill Net	-	-	46.2	0	-	-	-	-	-	-	-	-	-	-
Dip Net	-	-	11.5	1.82	-	-	-	-	-	-	-	-	-	-

Table 7-6. (cont.)

Month/Area/Gear	American Eels Effort	American Eels CPUE	River Herring Effort	River Herring CPUE	Atlantic Herring Effort	Atlantic Herring CPUE	Killifish Effort	Killifish CPUE	Rainbow Smelt Effort	Rainbow Smelt CPUE	Dogfish Effort	Dogfish CPUE	Atlantic Mackerel Effort	Atlantic Mackerel CPUE
Little Bay														
Minnow Trap	22.25	0.14	-	-	-	-	-	-	-	-	-	-	-	-
Oyster R.														
Minnow Trap	-	-	-	-	-	-	0.33	3.37	-	-	-	-	-	-
Gill Net	-	-	9.9	7.67	-	-	-	-	-	-	-	-	-	-
Cast Net	-	-	1	27	-	-	-	-	-	-	-	-	-	-
Salmon Falls R.														
Dip Net	-	-	3.07	30.84	-	-	-	-	-	-	-	-	-	-
Cast Net	-	-	0.25	18	-	-	-	-	-	-	-	-	-	-
Cocheco R.														
Cast Net	-	-	0.5	40	-	-	-	-	-	-	-	-	-	-
Great Bay														
Eel Pot	42	0.04	-	-	-	-	-	-	-	-	-	-	-	-
Minnow Trap	26	0.19	-	-	-	-	-	-	-	-	-	-	-	-
Seabrook-Coastal														
Gill Net	-	-	-	-	288	0.26	-	-	-	-	-	-	288	0.6
Squamscott R.														
Eel Pot	2	2.25	-	-	-	-	-	-	-	-	-	-	-	-
Dip Net	-	-	16	34.68	-	-	-	-	-	-	-	-	-	-
Wire Basket	-	-	12	80.25	-	-	-	-	-	-	-	-	-	-
Cast Net	-	-	11.07	16.2	-	-	-	-	-	-	-	-	-	-
July														
Bellamy R.														
Minnow Trap	-	-	-	-	-	-	2.66	6.11	-	-	-	-	-	-
Hampton-Coastal														
Gill Net	-	-	-	-	-	-	-	-	-	-	-	-	34.5	2.59
Great Bay														
Eel Pot	56	0.01	-	-	-	-	-	-	-	-	-	-	-	-
Oyster R.														
Minnow Trap	-	-	-	-	-	-	0.25	13.5	-	-	-	-	-	-
Seabrook-Coastal														
Gill Net	-	-	-	-	-	-	-	-	-	-	-	-	7200	0.06
August														
Bellamy R.														
Minnow Trap	-	-	-	-	-	-	6.25	3.11	-	-	-	-	-	-
Great Bay														
Eel Pot	14	0	-	-	-	-	-	-	-	-	-	-	-	-
Seabrook-Coastal														
Gill Net	-	-	-	-	280	0.98	-	-	-	-	-	-	-	-
Squamscott R.														
Eel Pot	105	0.4	-	-	-	-	-	-	-	-	-	-	-	-
September														
Bellamy R.														
Minnow Trap	-	-	-	-	-	-	3.5	2.63	-	-	-	-	-	-

Month/Area/Gear	American Eels Effort	CPUE	River Herring Effort	CPUE	Atlantic Herring Effort	CPUE	Killifish Effort	CPUE	Rainbow Smelt Effort	CPUE	Dogfish Effort	CPUE	Atlantic Mackerel Effort	CPUE
October														
Bellamy R.														
Minnow Trap	-	-	-	-	-	-	0.5	6.76	-	-	-	-	-	-
Seabrook-Coastal														
Gill Net	-	-	-	-	350	0.35	-	-	-	-	-	-	-	-
November														
Isle of Shoals														
Gill Net	-	-	-	-	-	-	-	-	-	-	44,911,144	0.02	-	-
December														
Grt Bay-Bay Rd-Mrsh														
Minnow Trap	-	-	-	-	-	-	22	0.22	-	-	-	-	-	-

PROGRESS REPORT

State: **NEW HAMPSHIRE** **Grant: F-61-R**

Grant Title: **NEW HAMPSHIRE ANADROMOUS FISH INVESTIGATION AND MARINE RECREATIONAL FISHERY EVALUATION**

Project 3: **MONITORING OF THE RAINBOW SMELT RESOURCE AND WINTER ICE FISHERY**

Objective: To annually monitor the resource of rainbow smelt (*Osmerus mordax*) and its fishery in the Great Bay Estuary system.

Period Covered: January 1, 2002 - December 31, 2002

Abstract:

A lack of ice cover during the winter of 2001-2002 resulted in little or no fishing for rainbow smelt in the Great Bay Estuary. Only 5 anglers were encountered during creel surveys this year. The limited data collected were deemed insufficient for examination of long-term catch and effort trends in this report.

The overall mean estimate of egg deposition increased for the first time since 1995. The estimate remains well below the long-term average, however.

Introduction:

New Hampshire's Great Bay Estuary traditionally provided a winter recreational and commercial smelt fishery. In 1977, complaints from fishermen concerning the quality of the fishery in recent winters led to an investigation into the problem by the New Hampshire Fish & Game Department. Length and age data were obtained from the catch of anglers during the winter fishery. These data were compared with earlier studies of smelt in the Great Bay area (Warfel 1943; Krochmal 1949). When an absence of two-year-olds was observed, indicating possible problems in recruitment, an emergency closure to the taking of smelt was enacted except during the winter ice fishery. This management

decision reduced fishing mortality and protected the spawning run, while providing for the opportunity to obtain information by creel survey. This action was followed by a five year study of the smelt resource and fishery from 1979 to 1983 under Federal Aid Project F-36-R. The results of that study illustrated a general decline in catch per unit of effort. Only one year out of five had a normal age distribution in the winter ice fishery. The egg deposition was, at best, one-sixth of the level considered to be optimal, roughly 13 eggs/cm2 (Rothschild 1961; McKenzie 1964). Further, the age distribution of smelt during the spawning run was dominated by two-year-olds.

A statewide fisheries management plan for rainbow smelt was written in 1981. The objectives for the sea run smelt management were:

1) Maintain or increase the sea run population of smelt.
2) Provide for a recreational smelt fishery.
3) Provide for a commercial smelt fishery.

Management measures implemented following development of the plan included closure of the fishery to net or weir fishermen from March 1 to December 15, a 10 quart daily possession limit, and implementation of a smelt egg transfer program. To evaluate the effectiveness of the management measures and detect trends in resource abundance, a creel survey of the recreational ice fishery has been conducted annually (except 1983-1986), coastal netters logbooks have been used to monitor bow netters and weir harvest of smelt (See Project I-7) and a smelt egg deposition survey has been conducted annually since 1979.

Procedure:

The winter smelt fishing creel survey is conducted from roughly ice in to ice out. In 2002, this occurred from January 23-30 and again from February 8-18.

The survey was conducted using a random schedule of two hour survey periods between 0600 - 2400 hours. Randomization was accomplished by using random numbers to select starting time and location from a table that only includes the period from two hours before to four hours following the high tide. The survey is limited to this time period because of the lack of fishing activity around low tide. Survey site selection was weighted by relative fishing effort from past surveys. At least one survey was scheduled for each day of the week with supplemental surveys added to ensure that each location was surveyed at least once during each weekday period and once during a weekend. The methodology resulted in a sampling intensity of roughly 7-9% of the time periods and locations on weekends and 4-5% on weekdays.

Survey personnel interviewed all anglers (or a sub-sample if they were unable to interview all anglers in the two hour survey period) for catch and effort (hours fished) information. The information was collected and then expanded by strata (weekend/weekday, location and month) to provide estimates of catch, effort, and catch per unit effort (CPUE) by month and location. The number of potential time blocks - three, two-hour blocks per fishing day - was used to estimate total effort and catch by area and month.

Length and sex information, as well as scales for aging, were taken weekly from a sample of the angler harvest. Sampling goals were 25 fish per location, per week for each week of the fishery. Scales were double aged using methods described by Bailey (1964).

Smelt egg deposition was evaluated by a series of sample egg counts on the natural substrate using a ring of known diameter (11.9 cm^2) and methodologies described by Rupp (1965). The mean number of eggs per square centimeter (or square foot) is used as an index of spawning stock abundance. Sample egg counts were conducted weekly, from mid-March to mid-April, in the Oyster, Bellamy, Lamprey, Squamscott and Winnicut rivers.

Results:

There was insufficient ice cover to support any concentrated fishing effort for Great Bay rainbow smelt during the 2001-2002 winter season. Some isolated effort was documented in the Squamscott and Oyster Rivers. Ice conditions were marginal at best and provided limited fishing opportunities for a period of less than three weeks. During this time, a total of 7 fish were measured as part of the creel survey. Estimates of total fishing effort and total catch appear in Table 3-1 for purpose of documenting the creel survey only. The amount of data collected, however, is insufficient for inclusion in long-term trend (Tables 3-2 and 3-3) or analysis.

Egg deposition estimates generated during the spring spawning run appear in Table 3-4. Efforts to document deposition in the Oyster and Winnicut Rivers resulted in estimates of zero eggs deposited at both locations. The Squamscott River showed the highest estimate of 1.40 eggs/cm^2.

Discussion:

A lack of ice cover during the 2001-2002 winter rainbow smelt fishing season resulted in insufficient data for examination of long-term catch and effort trends in this report.

The overall average estimate of egg deposition during the spring spawning run increased for the first time since 1995, Figure 3-1. This estimate remains well below the long-term mean of 0.88 eggs/cm^2, however. The optimal density of eggs for maximum prolarval production has been reported by Rothschild (1961) and McKenzie (1964) to be 12,000 and 11,745 eggs/ft^2 respectively (12.92 and 12.64 eggs/cm^2). Obviously, egg deposition in Great Bay estuary tributaries is well below the levels reported as optimal in the studies from Maine and New Brunswick mentioned above. Unfortunately, there is no local baseline information available on historical egg deposition rates for the Great Bay smelt population prior to 1979.

It seems very likely that the population of rainbow smelt in the Great Bay estuary, during the period covered by this creel survey, has been considerably lower than the populations of smelt that produced the egg deposition estimates cited above. Unfortunately, only anecdotal information exists to support the supposition that the Great Bay smelt population historically deposited eggs at or near these levels of production. Studies to determine the cause of an apparently low and declining level of reproductive effort for Great Bay Estuary rainbow smelt are in development.

Table 3-1. Estimates of catch, effort, and CPUE, by month and location, for the marine recreational ice fishery for rainbow smelt in New Hampshire, 2001-2002.

WEEKEND/WEEKDAY COMBINED

	LOCATION					
	Squamscott River	Lamprey River	Bellamy/ Oyster	Great Bay	Depot/ Winnicut	TOTALS & MEANS
DECEMBER						
No. of Angler Trips:	0	0	0	0	0	0
No. of Angler Hours:	0	0	0	0	0	0
No. of Smelt Caught:	0	0	0	0	0	0
Catch per Angler Hour:	0	0	0	0	0	0
Number of Interviews:	0	0	0	0	0	0
JANUARY						
No. of Angler Trips:	0	0	20	0	0	20
No. of Angler Hours:	0	0	41	0	0	41
No. of Smelt Caught:	0	0	14	0	0	14
Catch per Angler Hour:	0	0	0.4	0	0	0.4
Number of Interviews:	0	0	3	0	0	3
FEBRUARY						
No. of Angler Trips:	6	0	14	0	0	20
No. of Angler Hours:	12	0	28	0	0	40
No. of Smelt Caught:	6	0	0	0	0	6
Catch per Angler Hour:	0.5	0	0.0	0	0	0.2
Number of Interviews:	1	0	1	0	0	2
MARCH						
No. of Angler Trips:	0	0	0	0	0	0
No. of Angler Hours:	0	0	0	0	0	0
No. of Smelt Caught:	0	0	0	0	0	0
Catch per Angler Hour:	0	0	0	0	0	0
Number of Interviews:	0	0	0	0	0	0
TOTAL TRIPS	6	0	34	0	0	40
TOTAL ANGLER HOURS	12	0	69	0	0	81
TOTAL CATCH	6	0	14	0	0	20
% CATCH	29.4%	0	70.6%	0	0	
CPUE	0.5	0	0.2	0	0	0.3

Table 3-2. Estimates of catch, effort, CPUE of rainbow smelt, by month and location, during the Great Bay Estuary ice fishery in New Hampshire, from 1978-2002.

YEAR	MONTHS OF FISHERY	ESTIMATED # FISH	ESTIMATED LBS. FISH	CPUE (FISH/ ANGLER HR.)	TRIPS	ANGLER HOURS
1978	D-M	197,989	19,799	11.4	9,054	17,426
1979	D-M	225,090	22,509	6.8	10,256	33,044
1980	J-M	21,278	2,128	1.1	3,170	19,600
1981	D-F	413,944	41,394	5.9	41,749	69,609
1982	J-M	60,430	6,043	1.3	30,101	47,083
1983			**NO SURVEY**			
1984			**NO SURVEY**			
1985			**NO SURVEY**			
1986			**NO SURVEY**			
1987	J-M	334,755	33,476	5.8	30,262	57,187
1988	J-M	281,365	28,137	5.3	27,206	53,136
1989	D-M	493,452	49,345	10.2	27,232	48,286
1990	D-M	342,205	34,221	5.7	31,176	59,949
1991	J-F	96,370	9,637	2.3	22,293	42,754
1992	D-M	43,287	4,329	1.5	15,673	29,687
1993	D-M	87,393	8,739	3.6	12,753	24,269
1994	J-M	93,708	9,371	2.9	16,775	32,344
1995	J-M	238,888	23,889	9.7	12,576	24,627
1996	D-M	192,356	19,236	4.9	20,222	39,100
1997	J-F	31,433	3,143	2.6	6,408	12,103
1998	D-F	7,254	725	2.0	1,851	3,591
1999	J-F	22,595	2,260	2.5	4,748	8,924
2000	D-M	84,203	8,420	4.0	10,843	20,802
2001	D-M	162,397	16,240	5.6	14,997	29,089
2002	Insufficient data due to lack of a fishery (no ice formation)					

Table 3-3. Percent age distribution of harvested smelt from the Great Bay Estuary ice fishery in New Hampshire, 1978-2002 (sexes combined).

YEAR	I	II	III	IV	V+	SAMPLE SIZE
1978+	0.0	1.3	61.3	34.2	3.3	240
1979+	0.0	47.3	32.6	16.1	4.0	862
1980+	0.0	39.3	56.0	4.7	0.0	150
1981+	0.0	23.9	62.4	12.1	1.6	377
1982+	0.0	31.5	40.9	24.0	4.6	499
1983						
1984						
1985						
1986						
1987+	0.0	45.6	45.8	8.0	0.6	327
1988+	0.0	58.6	31.1	9.8	0.5	428
1989+	0.0	59.6	32.3	6.9	1.2	495
1990+	0.0	40.8	52.5	6.3	0.5	608
1991+	0.0	30.8	49.4	16.1	3.7	354
1992+	0.0	57.1	29.5	12.4	1.0	597
1993						
1994+	0.0	37.1	59.0	3.1	0.8	512
1995*	0.0	33.7	54.9	10.5	0.9	521
1996*	0.0	43.1	41.3	13.2	1.6	756
1997*	0.0	17.9	66.1	14.7	1.3	209
1998*	0.0	80.6	11.3	6.1	2.0	171
1999*	0.0	43.8	51.0	4.9	0.3	306
2000*	0.0	57.2	27.0	14.2	1.7	596
2001*	0.2	15.8	59.2	19.8	5.0	682
2002	Insufficient data due to lack of a fishery (no ice formation)					

* = Calculated by weighting the sample percentage age distribution by catch estimates.
+ = Raw age distribution from biological samples.

Table 3-4. Smelt egg deposition index as calculated by the mean number off eggs/ft^2 (and cm^2) recorded in selected rivers in Great Bay Estuary, NH from 1979-2002

	Bellamy		Oyster		Lamprey		Squamscott		Winnicut		Average	
	#/cm^2	#/ft^2	#/cm^2	#/ft^2	#/cm^2	#/ft^2	#/cm^2	#/ft^2	#/cm^2	#/ft^2	#/cm^2	#/ft^2
1979	1.96	1,819	0.98	908	0.55	510	-	-	0.00	0.00	1.16	1,079
1980	1.34	1,244	1.07	994	1.05	975	2.25	2,090	1.27	1,179	1.40	1,296
1981	6.05	5,620	0.36	334	1.01	938	2.87	2,666	0.56	520	2.17	2,016
1982	1.10	1,021	0.87	808	2.40	2,229	0.74	687	0.06	56	1.03	960
1983	1.27	1,179	0.44	408	1.80	1,672	2.36	2,192	0.20	183	1.21	1,127
1984	2.24	2,081	2.02	1,877	1.20	1,115	1.06	985	0.14	129	1.33	1,237
1985*	2.16	2,006	1.62	1,505	2.55	2,369	3.79	3,521	1.06	985	1.69	1,569
1986	0.48	446	1.16	1,076	0.25	232	1.34	1,251	1.13	1,049	1.04	963
1987	0.90	832	0.82	757	1.11	1,031	1.02	943	-	-	0.81	752
1988	0.63	584	1.14	1,063	0.38	350	2.05	1,905	0.44	409	1.06	982
1989	0.26	240	0.24	222	0.31	284	3.46	3,214	0.28	260	0.91	844
1990	0.80	739	0.22	200	0.02	19	1.34	1,241	0.06	53	0.48	450
1991	0.43	399	0.32	297	1.36	1,259	2.58	2,397	0.003	3	0.94	872
1992	0.29	269	0.38	351	0.27	250	2.75	2,553	0.24	223	0.79	729
1993**	0.24	224	0.27	253	0.10	95	1.95	1,809	0.05	43	0.52	484
1994	0.45	414	1.02	943	1.85	1,716	0.79	735	0.44	408	0.91	843
1995	1.24	1,148	1.96	1,819	2.07	1,920	3.28	2,787	0.22	203	1.75	1,575
1996	0.57	532	0.47	437	0.29	266	1.15	1,067	0.02	18	0.50	464
1997	0.05	42	0.02	19	0.05	45	1.38	1,278	0.00	0.00	0.38	346
1998	0.16	147	0.01	8	0.83	773	0.41	381	0.03	23	0.29	267
1999	0.07	67	0.11	101	0.09	86	0.81	749	0.11	105	0.24	222
2000	0.27	251	0.02	21	0.16	145	.037	343	0.00	0	0.16	152
2001	0.04	36	0.001	1	0.03	25	0.04	35	0.002	2	0.02	20
2002	0.02	21	0.00	0	0.38	351	1.40	1301	0.00	0	0.36	334

* Low flow year
** High water and limited access to spawning areas during spawning

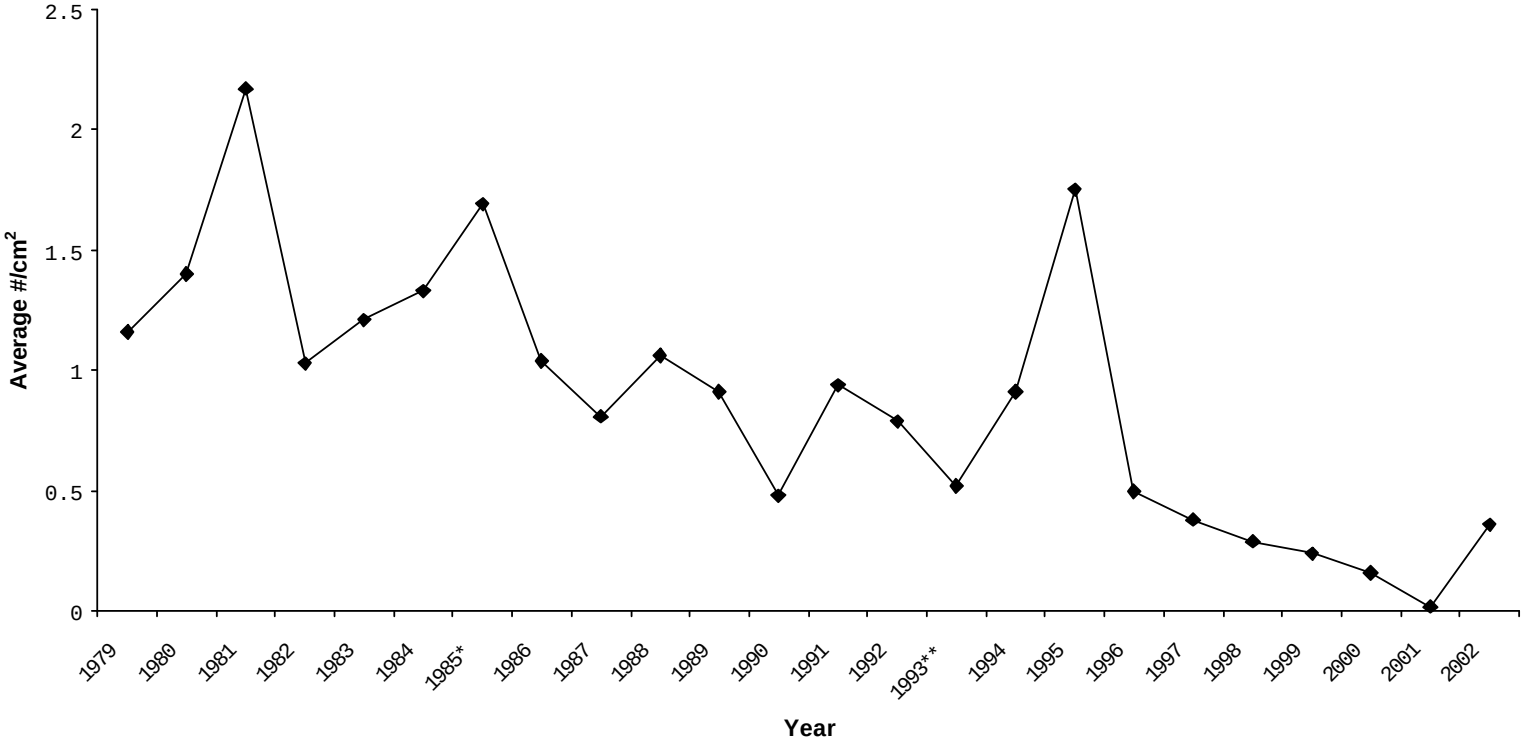

Figure 3-1. Rainbow Smelt egg depostion estimates for the Great Bay Estuary, NH between 1979 and 2002.

Fish and Wildlife Service (USFWS), approximately 5,800 river herring were transferred into impoundments or lakes in the Merrimack River and Great Bay Estuary drainages to enhance existing spawning populations.

Introduction:

New Hampshire's coastal rivers once supported abundant runs of anadromous fish including river herring (alewife and blueback herring) [Jackson 1944]. River herring are forage for predatory fish in fresh and saltwater. They are harvested by various types of nets, baskets and weir primarily for bait in lobster traps or for striped bass fishing. They can also be smoked or pickled for human consumption. In the 1800s, dams built by the textile industry in the major rivers denied anadromous species access to large areas of spawning habitat. Unlike the Atlantic salmon and American shad that were eliminated by these barriers, the river herring only declined in numbers, as they were able to utilize the small area of fresh water just below the dams for spawning.

In other areas, river herring runs have been restored by stocking alewives (Rounsefell and Stringer 1945, Bigelow and Schroeder 1953) constructing fishways or by removing defunct dams (Havey, 1961).

In the late 1960s and early 1970s, fishways were constructed with state and federal resources at dams in the Lamprey, Exeter, Cocheco, Winnicut, Taylor, and Oyster rivers in Rockingham and Strafford counties, re-opening many acres of freshwater spawning and nursery habitat for river herring. The river herring runs in the Lamprey River have been monitored since 1972. Estimates or actual counts of fish passed above the fishways, sample lengths, sex ratios and age data are available from previous studies under Federal Aid Projects F-36-R and F-50-R. The Exeter fishway and Winnicut step-weir type fishway have historically been inefficient at passing river herring. However, modifications have recently been made to the Winnicut fishway in 1998 and Exeter fishway in 2000 to improve the effectiveness of the structures for passing fish.

Procedures:

Seven fish ladders on six coastal New Hampshire rivers (Cocheco, Exeter, Lamprey, Oyster, Winnicut, and Taylor rivers) were operated from early April to late June to allow passage of river herring and other anadromous fish upriver to historical spawning and nursery areas. Numbers of river herring passing through the fishways were either enumerated by hand

passing or estimated by the use of Smith-Root Model 1100 electronic fish counters. Counts recorded by the electronic fish counters were adjusted by the results of periodic calibration counts.

Length measurements, sex determination, and scale samples for age determination were obtained from all fishways in 2002. The biological information was generally collected during the beginning, middle and end of the spawning runs. Each sample attempted to gather approximately 150 length measurements (total length in millimeters) and sex determinations, depending on availability of fish. Scale samples were also taken from approximately 50 fish per sample when available.

Scale samples were cleaned, mounted on glass slides, and aged using an overhead scale projector via methods described by Marcy (1969). Scale samples were also used for species determination (i.e. alewife or blueback herring) using methods described by MacLellan et al. (1981). At least two independent readers aged all scales.

This year, New Hampshire Fish and Game (NHFG) and the USFWS continued a cooperative trap and transport program to enhance river herring runs in New Hampshire rivers. During the spawning run, river herring were collected from the coastal fishways and transported to impoundments or lakes in both coastal and Merrimack River watersheds. In-river transfers were also conducted in the Lamprey and Cocheco River systems. During this program, out-of-basin transfers were limited to 10% of the spawning run in each river.

Results:

Estimated numbers of spawning adult river herring passing through the six monitored fishways ranged from 3,341 at the Exeter fish ladder to 62,472 at the Cocheco River (Table 2-1). In general, this years river herring runs began in mid to late April at the Cocheco, Lamprey, Oyster, and Exeter rivers (Table 2-2). However, the runs in the Winnicut and Taylor rivers did not begin until May 7 and May 23, respectively. The water temperatures during the peak of the spawning runs ranged from 14.0° C in the Exeter and Oyster rivers to 17.0° C in the Lamprey.

Summary of biological data collected from samples of river herring migrating through all the fishways is presented in Table 2-3. Males dominated the length samples by numbers in all the rivers except the Taylor. Alewives comprised all of the fish sampled in the spawning run of the

Lamprey River, 96% of the run in the Exeter River, and the majority of the run (64%) in the Cocheco River. Blueback herring made up 100% of the sampled fish in the Oyster and Taylor Rivers.

Table 2-4 presents results of age analysis of the 658 river herring scales sampled from all of the fishways in 2002. Age IV and V fish dominated the river herring sampled in the Cocheco, Oyster, Exeter, and Winnicut Rivers. Both the Lamprey and Taylor Rivers were dominated by age V and VI fish, with the age VI fish accounting for 30% and 53%, respectively. Age III cohorts comprised nearly 20% of the overall age distributions from sampled river herring in the Winnicut River and 12% in the Cocheco River. The age III cohorts in the Exeter, Oyster, Lamprey, and Taylor rivers accounted for less of the spawning run, ranging from 9% in the Oyster to as low as 2% in the Lamprey. Older fish (age VII+) were represented in all sampled rivers in 2002 except the Exeter River.

Approximately 5,800 river herring were transferred via stocking trucks from two coastal fishways; 1,900 from the Lamprey River and 3,900 from the Cocheco River (Table 2-5). Two thousand nine hundred river herring were transferred out-of-basin to Northwood Lake and the Suncook River in the Merrimack River system. Transfers of fish to New Hampshire's coastal river drainages included 1,900 river herring to Pawtuckaway Lake in the Lamprey River drainage and 1,000 fish to Bow Lake in the Cocheco River drainage system to enhance the current spawning runs.

Discussion:

In 2002, the numbers of spawning adult river herring utilizing New Hampshire coastal fishways increased by 17% from 2001 to 195,467 fish, the highest number since 1992(Table 2-1). The number of spawning river herring continued to increase in the Cocheco, Lamprey and Winnicut rivers. The Oyster River spawning run declined for the third consecutive year in 2002. This years decline in spawning fish in the Oyster River has placed it behind the spawning runs for both the Cocheco and Lamprey Rivers, after having the largest spawning run for the last eighth years. River herring using the Taylor River fish ladder have continued to decrease dramatically from 44,010 fish in 2000 to 7,065 fish in 2001, and now 5,829 fish in 2002.

It was suggested in 2001, that one potential cause for the low numbers of returns at the Taylor fish ladder may have been the installation of an Irish elver trap that is used to collect young-of-the-year American eels (*Anguilla rostrata*). The Irish elver trap was designed to attach to the

last baffle of the fish ladder and sample the elvers entering the mouth of the fish ladder. However, in an attempt to avoid possible changes in water flow dynamics that may have prevented river herring from utilizing the fish ladder in 2001, the trap was not installed this year. The absence of the Irish elver trap did not serve to increase the passage of river herring as suspected, and suggests that there are other factors influencing the usage of the Taylor River fishway. However, large accumulations of fish were never observed below the dam this year, suggesting that all or most of those river herring reaching the dam were able to ascend the fishway.

The duration of the run of spawning river herring in the Taylor River was 14 days in 2002, the shortest to date, and only one quarter of the duration seen in 2001. Difficulties throughout the season with setup and calibration of the counter box and a high flow event in mid-May could be a possible explanation for the low number of river herring counted through the fishway and for the short duration of the spawning run. It is possible that a pulse of fish passed through the fishway before the high flow event in mid-May and was not recorded by the counter box.

The run of spawning fish through the Exeter fish ladder decreased in 2002 by 50% from the numbers seen in 2001. The lower number of returning river herring this year correlates with a decrease in numbers of spawning river herring passing through the fishway between 1997 and 1998. Recruitment of four year old spawning fish into the population from the 1998 return of 392 fish would be expected to be much less than the recruitment from 1997, where 1,302 fish returned.

However, it is important to note that even with this large drop in numbers of fish from last year, the number of spawning fish using the fishway (3,341 fish) is still the highest level seen since 1981 with the exception of 2001. These greater numbers of fish using the ladder the past two years are most likely due to design upgrades completed in the fall of 2000. Historically, several thousand river herring appeared near the base of the dam at the end of May but only a small fraction of them ascend the ladder. In order to improve the fish passage effectiveness, the top of the dam was raised on either side of the ladder mouth to minimize spillage near the entrance to the fishway. The higher return numbers to the ladder in 2002 and 2001, indicate that the modifications improve attraction and allow more river herring to find the mouth of the ladder.

Historically, alewives have been the dominant species using the Exeter River ladder in most years (Grout et al. 1999, 2000, 2001); but data

collected from 2001 indicated an increase in usage of the fishway by blueback herring possibly resulting from the recent modifications. The large percentage of bluebacks seen in 2001 (60%), did not occur in 2002, but instead dropped to 4%. This dramatic change in species proportions from 2001 to 2002 is possibly a result of the limited number of biological samples obtained in 2002 due to the low numbers of fish present in the ladder during times of sampling in 2002. Numbers of sampled fish were also reduced this year due to the installation of a fish counting tube like those used in the Lamprey, Oyster, Taylor, and Winnicut rivers, that allowed river herring to continually pass through fishway rather than accumulating to higher numbers.

Summary data from biological samples show that the rivers with spawning runs dominated by bluebacks, including the Oyster and Taylor rivers in 2002, had smaller mean lengths for both sexes compared to the Cocheco, Exeter, and Lamprey rivers which were dominated by alewives (Table 2-3). The larger mean lengths in the rivers with mostly alewives may not be due to an older age distribution, but simply the result of blueback herring generally being smaller in size at a given age than alewives. This difference can be seen most prominently by comparing biological data from the Lamprey and Oyster Rivers where the mean size at age of alewives from the Lamprey are at least 1 cm larger than the blueback herring in the Oyster River (Table 2-4). The exception to this occurred in the Winnicut River, which had mean lengths similar to rivers dominated by blueback herring despite having alewives account for 54% of sampled fish.

The Lamprey River's spawning stock of alewives continued to increase from a low of 11,200 fish in 1996 to 58,605 in 2002 with nearly a 50% increase from 2001 (Table 2-1). To enhance future runs, approximately 1,900 alewives from the Lamprey River fish ladder were transferred to Pawtuckaway Lake to utilize inaccessible spawning and nursery habitat within the Lamprey River drainage system. These annual in-river transfers of spawning fish were initiated in 1994 (Table 2-6) and appear to be influencing the large numbers of age IV through VII^{+} fish in this year’s spawning run and the continual increase in river herring returns observed in recent years.

For the third consecutive year, the numbers of returning river herring to the Cocheco River have increased in 2002 following four years of decline between 1995 and 1999 (Table 2-1). As seen in 2001, the increase appears to have been driven by good recruitment from the 1996, 1997 and 1998 year classes which made up nearly 78% of the 2002 spawning run as age IV, V and

VI individuals. In fact, 50% of the sampled spawning fish from the Cocheco River were age VI and greater, as compared to values of 27%, 21%, 19%, and 18% for the Oyster, Cocheco, Exeter, and Winnicut rivers, respectively (Table 2-4). Only the Taylor River had a higher percentage of older fish (73%), but this is most likely an artifact of the small sample size (n = 30).

Trap and transport operations from the Cocheco fish ladder continued in 2002 with approximately 1000 river herring transported to Bow Lake, an impoundment in the watershed (Table 2-6). The transfers appear to have driven the sharp increases in the spawning run observed in the 1990s, most notably during 1992 and 1995 (Table 2-1).

This year marks the fifth year of successful passage of river herring through the Winnicut River fish ladder since modifications were made in 1998. Additional changes to the water flow dynamics of the fishway were also implemented this year by altering the position of chutes located within each pool of the ladder. These changes served to effectively reduce the eddying effect of water within each pool, which may have prevented more fish from utilizing the ladder in previous years. The 7,041 river herring using the ladder in 2002 are the highest on record (Table 2-1). The number of fish seen in 2002 is almost seven times that seen in 2001 and nearly thirty times greater than the return originally seen after modifications were made in 1998. Enhancement stocking of spawning river herring in the Winnicut River from 1998 through 2000 may have supported this increase in returning fish. Age III and IV fish (possible progeny of those stocked in 1998 and 1999) accounted for more than 60% of the total return.

River herring sampled from the Cocheco, Exeter, Oyster, and Winnicut rivers showed high percentages of age IV and V individuals (Table 2-4). As suggested in 2001, the large numbers of age IV and V fish indicate good recruitment from 1997 and 1998 year classes. The spawning runs for both the Lamprey and Taylor rivers were dominated in 2002 by age V and VI fish, with the Taylor River having more than 53% of its spawning run accounted for by age VI fish alone. However, the relatively small sample size obtained from the Taylor River may account for the difference from the other rivers in 2002. A decline in the percentage of age III individuals from 2001 was seen in the Cocheco, Exeter, Oyster and Lamprey rivers, suggesting a year of lowered recruitment in 1999. This trend may have also occurred in the Taylor and Winnicut rivers, although no comparisons could be made due to incomplete age structure data from these rivers in 2001. However, the

Winnicut River did show the highest percentage of age III fish, nearly 20%, in 2002(Table 2-4).

In summary, the total number of river herring using the coastal river fish ladders increased in 2002 after a decline in 2001. The largest increases in the number of returning fish were seen in the Cocheco, Lamprey and Winnicut rivers, while the Exeter, Oyster, and Taylor rivers showed declines. The recent modifications to the Winnicut fishway are largely responsible for significant changes in the dynamics of attracting and passing more river herring. The Winnicut River return this year is the highest to date and nearly seven times that seen in 2001.

Trap and transport operations in the Lamprey and Cocheco River continue to enhance the population of river herring along with good recruitment of the 1997 and 1998 year classes. The stocking of spawning river herring in the Winnicut River, beginning in 1998 has also served to dramatically increase the number of returning fish to this river.

Table 2-1. Numbers of river herring returning to fishways on coastal New Hampshire rivers from 1972 - 2002.

YEAR	COCHECO RIVER	EXETER RIVER	OYSTER RIVER	LAMPREY RIVER	TAYLOR RIVER	WINNICUT RIVER
1972				2,528		+
1973				1,380		+
1974				1,627		+
1975		2,639		2,882		+
1976	9,500		11,777	3,951	450,000	+
1977	29,500		359	11,256		2,700++
1978	1,925	205	419	20,461	168,256	3,229++
1979	586	186	496	23,747	375,302	3,410++
1980	7,713	2,516	2,921	26,512	205,420	4,393++
1981	6,559	15,626	5,099	50,226	94,060	2,316++
1982	4,129	542	6,563	66,189	126,182	2,500++
1983	968	1	8,866	54,546	151,100	+
1984	477		5,179	40,213	45,600	+
1985	974		4,116	54,365	108,201	+
1986	2,612	1,125	93,024	46,623	117,000	1,000++
1987	3,557	220	57,745	45,895	63,514	+
1988	3,915		73,866	31,897	30,297	+
1989	18,455		38,925	26,149	41,395	+
1990	31,697		154,588	25,457	27,210	+
1991	25,753	313	151,975	29,871	46,392	+
1992	72,491	537	157,024	16,511	49,108	+
1993	40,372	278	73,788	25,289	84,859	+
1994	33,140	*	91,974	14,119	42,164	+
1995	79,385	592	82,895	15,904	14,757	+
1996	32,767	248	82,362	11,200	10,113	+
1997	31,182	1,302	57,920	13,788	20,420	+
1998	25,277	392	85,116	15,947	11,979	219
1999	16,679	2,821	88,063	20,067	25,197	305
2000	30,938	533	70,873	25,678	44,010	525
2001	46,590	6,703	66,989	39,330	7,065	1,118
2002	62,472	3,341	58,179	58,605	5,829	7,041

* - Due to damage to the fish trap, fishway became a swim through operation.
+ - Fishway unable to pass fish until modifications in 1997.
++ - Fish netted below and hand passed over Winnicut River dam.

Table 2-2. Summary data for river herring spawning runs for coastal New Hampshire rivers, 2002.

RIVER	RIVER HERRING RUN		TEMPERATURE (^{o}C)			RETURN (#'s)	COUNT METHOD*
	START	END	MIN.	MAX.	PEAK+		
COCHECO	4-17-02	6-23-02	6.5	20.0	15.5	62,472	H
EXETER	4-27-02	6-20-02	8.0	19.0	16.5	3,341	E, H
OYSTER	4-22-02	6-27-02	7.0	21.0	15.0	58,179	E, H
LAMPREY	4-12-02	6-14-02	12.0	19.0	15.5	58,605	E, H
TAYLOR	5-23-02	6-5-02	15.0	24.0	17.5	5,829	E, H
WINNICUT	5-7-02	6-26-02	7.0	21.5	15.5	7,041	E, H

+ - Temperature at peak of spawning run
* - H = hand count; E = electronic counter

Table 2-3. Mean length (total length in centimeters), percent sex composition and percent species composition of river herring spawning runs from samples obtained at coastal New Hampshire fish ladders, 2002.

RIVER	MEAN LENGTH (cm)		% MALE	% FEMALE	N	% ALEWIFE	% BBH
	MALE	FEMALE					
COCHECO	27.3	28.7	59.6	40.4	453	64	36
EXETER	27.2	28.2	63.1	36.9	160	96	4
OYSTER	25.9	27.0	69.0	31.0	474	0	100
LAMPREY	29.2	30.6	58.2	41.8	459	100	0
TAYLOR	26.9	28.8	38.5	61.5	30	0	100
WINNICUT	25.5	26.5	73.7	26.3	453	54	46

Table 2-4. River herring age distribution, by length, from scale samples taken at the Cocheco, Exeter, Lamprey, Oyster, Winnicut, and Taylor River fish ladders during the spring spawning run, 2002.

Area: Cocheco River **Sex: Both**

Length Group (cm)	III
22	
23	3
24	7
25	5
26	2
27	
28	

29	
30	
31	
32	
33	
34	
35	
36	
37	
Total	17
% Dist.	11.6
Mean	24.8
Minimum	23.0
Maximum	26.7

Table 2-4 continued.

Area: Exeter/Squamscott River **Sex: Both**

	Age					
	III	IV	V	VI	VII+	Total
Length Group (cm)						
22						
23						
24						
25		1				1

26	2	6	2		10
27		2	9		11
28		5	11	6	22
29		1	4	4	9
30			1		1
31					
32					
33					
34					
35					
36					
37					
Total	2	15	27	10	54
% Dist.	3.7	27.8	50.0	18.5	
Mean	26.6	27.3	28.1	28.7	
Minimum	26.5	25.5	26.2	28.1	
Maximum	26.6	29.6	30.4	29.3	

Table 2-4 continued.

Area: Oyster River **Sex: Both**

	Age					
	III	IV	V	VI	VII+	Total
Length Group (cm)						
22						
23	1	1				2
24	5	25	6			36
25	4	20	4	1		29
26	2	6	6	4		18
27		2	14	14	5	35
28			4	6	2	12
29			3	3	3	9
30					1	1
31						
32						
33						
34						
35						
36						
37						
Total	12	54	37	28	11	142
% Dist.	8.5	38.0	26.1	19.7	7.7	
Mean	25.0	25.2	26.8	27.6	28.4	
Minimum	23.6	23.4	24.2	25.0	27.3	
Maximum	26.4	27.5	29.6	29.4	30.6	

Table 2-4 continued.

Area: Lamprey River **Sex: Both**

Length Group (cm)	Age III	IV	V	VI	VII+	Total
22						
23						
24						
25	1					1
26	1	7				8
27	1	8	2			11
28		8	15	3		26
29		4	11	13	6	34
30		1	7	14	8	30
31			3	9	8	20
32			1	2	2	5
33				1	1	2
34					2	2
35						
36						
37						
Total	3	28	39	42	27	139
% Dist.	2.2	20.1	28.1	30.2	19.4	
Mean	26.2	27.9	29.4	30.4	31.0	
Minimum	25.0	26.2	27.3	28.4	29.3	
Maximum	27.4	30.6	32.7	33.0	34.1	

Table 2-4 continued.

Area: Taylor River **Sex: Both**

Length Group (cm)	Age III	IV	V	VI	VII+	Total
22						
23	1					1
24						
25						
26		1	1	1		3
27			3	4		7
28			2	6	2	10
29				5	4	9
30						
31						
32						
33						
34						
35						
36						
37						
Total	1	1	6	16	6	30
% Dist.	3.3	3.3	20.0	53.3	20.0	
Mean	23.6	26.6	27.5	28.4	29.1	
Minimum	23.6	26.6	26.4	26.5	28.8	
Maximum	23.6	26.6	28.1	29.9	29.5	

Table 2-4 continued.

Area: Winnicut River **Sex: Both**

Sex: Both

Length Group (cm)	Age III	IV	V	VI	VII+	Total
22						
23	2					2
24	11	25				36
25	15	25	7			47
26	1	10	14	9		34
27		1	7	8	1	17
28			2	3	2	7
29					2	2
30						
31					1	1
32						
33						
34						
35						
36						
37						
Total	29	61	30	20	6	146
% Dist.	19.9	41.8	20.5	13.7	4.1	
Mean	25.0	25.2	26.6	27.3	28.8	
Minimum	23.3	24.0	25.0	26.3	27.6	
Maximum	26.1	27.1	28.8	28.8	29.6	

Table 2-5. Summary of anadromous river herring transfers from the Cocheco and Lamprey rivers during 2002.

DATE	# TRANSFERRED	SOURCE OF RIVER HERRING	STOCKING LOCATION	DRAINAGE SYSTEM
4/23/02	600	Lamprey River	Pawtuckaway L.	Lamprey River
4/24/02	200	Lamprey River	Pawtuckaway L.	Lamprey River
4/24/02	200	Lamprey River	Pawtuckaway L.	Lamprey River
5/7/02	500	Lamprey River	Pawtuckaway L.	Lamprey River
5/9/02	400	Lamprey River	Pawtuckaway L.	Lamprey River
5/12/02	1000	Cocheco River	Bow Lake	Cocheco River
5/12/02	1150	Cocheco River	Northwood L.	Merrimack River
5/13/02	1150	Cocheco River	Northwood L.	Merrimack River
5/13/02	600	Cocheco River	Suncook River	Merrimack River

Table 2-6. Numbers of river herring stocked in coastal New Hampshire rivers from 1984 - 2002.

YEAR	COCHECO RIVER SYSTEM	WINNICUT RIVER	EXETER RIVER	LAMPREY RIVER SYSTEM	SALMON FALLS RIVER
1984	5,000				
1985	500				
1986	2,000				
1987	2,125				
1988	2,000				
1989					
1990	2,000				
1991	1,700				
1992	1,300				
1993					
1994	365[a]			320[a]	220
1995	1,400[a]		125	3,230[b]	250
1996	750[a]			2,100[a]	200
1997	950[a]			2,000[a]	300
1998	1,000[a]	300		1,975[a]	240
1999	990[a]	200		2,020[a]	200
2000	1,000[a]	430		2,020[a]	320
2001	1,000[a]			2,000[a]	200
2002	1,000[a]			1,900[a]	

[a] - In-river transfer.
[b] - Combination of in-river and out-of-basin transfers.